ATTACHMENT A

AIRBAG FOR INSTALLATION IN A MOTOR VEHICLE

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to German patent application 102004006185.8, filed February 6, 2004 and PCT/EP2005/001108, filed February 4, 2005.

BACKGROUND

1. Field of the Invention

[0002] The invention relates to an airbag for installation in a motor vehicle.

2. Description of Related Art

[0003] Traditionally, airbags are provided with one or several outflow openings and are filled by means of a gas generator unit with a specified performance profile. Because of the geometry of the airbag, the performance profile of the gas generator unit, the cross-section of the outflow opening or openings, and the internal pressure of the airbag a certain firmness results when it is inflated.

[0004] Ideally, the hardness of an airbag, in particular the firmness of an airbag used in a side airbag system, should be adapted to the body weight of the vehicle occupants. A relatively light occupant requires an airbag with less firmness, in other words with lower internal pressure, so that the force exerted by the airbag is as low as possible when the relevant part of the body, for example

the upper part of the torso (i.e. thorax), strikes the airbag. Heavier vehicle occupants, on the other hand, require an airbag with greater internal pressure, otherwise the overall retaining pressure for the occupant may be too low and there is a risk that the occupant will strike the structure of the vehicle despite the presence of the airbag.

[0005] It is generally not possible to design each airbag in a vehicle to accord with the requirements of the specific occupants to be protected, as a vehicle is generally used by several people. It would therefore be desirable to have an airbag which "recognizes" if it has to protect a light or a heavy occupant and which is configured to provide different hardnesses as required.

[0006] In addition, a similar problem to the one described above also arises in the case of so-called "out of position occupants". Airbags are generally designed in such a way that they protect vehicle occupants who are in a "normal" seating position. If the occupant is in an atypical seating position, he or she may find his or herself in the direction of expansion of the airbag, resulting in a possibility of injury. United States Patent 6,783,151 proposes an airbag which accommodates an occupant positioned in the direction of expansion of the airbag, and limits the expansion of the airbag in response. Multiple embodiments of U.S. 6,783,151 accommodates an out of position occupant.

[0007] In a first embodiment, the airbag includes two chambers, which are connected with each other by a valve arrangement. This valve arrangement is designed and implemented in such a way that the valve remains closed or

restricted if the airbag strikes an obstacle during expansion. In this case, only one chamber of the airbag is filled, so that the direction of expansion is shortened.

[0008] In another embodiment, the outer cover of the airbag includes a valve which is only closed if the airbag does not meet an obstacle. If the airbag does meet an obstacle, the valve remains open, keeping the expansion and pressure in the airbag low.

[0009] The airbag embodiments proposed in U.S. 6,783,151 serve to limit the expansion of the airbag in the presence of an obstacle. The type of obstacle, for example, whether the vehicle occupant is large and heavy or small and light, does not play a role. Such factors are also not necessary in order to solve the task of the present invention.

[0010] The task of the present invention is to create an airbag which provides a different firmness depending on certain physical characteristics of the vehicle occupants.

SUMMARY

[0011] In satisfying the above need, as well as overcoming the drawbacks and other limitations of the related art, the present invention provides a side airbag capable of accommodating and responding to vehicle occupants of differing weights. The physical size of the vehicle occupant is selected as a criterion for the different inflation states of the side airbag, since size is generally

closely related to the weight of the occupant and can be more easily accommodated by the airbag without external sensors.

[0012] The side airbag of the present invention includes at least one main chamber and at least one auxiliary chamber, whereby these chambers are connected with each other by a connecting opening. The auxiliary chamber includes an outflow opening through which gas from a gas generator exits. A closing element is included with the outflow opening to block the flow of gas to the outflow opening, wholly or in part, when the auxiliary chamber meets an obstacle during or after expansion of the airbag.

[0013] In addition, the side airbag is dimensioned and arranged in such a way that the main chamber and is, in the case of a large occupant, located at the upper chest of the large occupant. In the case of a small occupant, the main chamber is located above the shoulders. If the large occupant meets such an airbag, the outflow opening is blocked, which means that the pressure in the main chamber is increased accordingly. However, in the case of the small occupant, the outflow opening remains linked to the main chamber, allowing gas to flow out of the main chamber, reducing the pressure in the main chamber, and resulting in a softer airbag.

[0014] In a preferred embodiment of the present invention, the auxiliary chamber includes an inner and an outer chamber. The outer chamber is connected with the main chamber and the auxiliary chamber by a valve opening which connects the outer chamber with the outflow opening associated with the inner chamber. If the auxiliary chamber encounters an obstacle, a part of a fabric

layer of the outer chamber is pressed onto the valve opening, and the gas path between the main chamber and the outflow opening is interrupted.

[0015] Further objects, features and advantages of this invention will become readily apparent to persons skilled in the art after a review of the following description, with reference to the drawings and claims that are appended to and form a part of this specification.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] Figure 1 is a perspective view of an airbag according to the principles of the present invention;

[0017] Figure 2 is a section view of the airbag of Figure 1 along Plane A;

[0018] Figure 3 is a detail view of an upper portion of the airbag of Figure 2;

[0019] Figure 4 is a front view of the airbag of Figure 1 inflating beside a large vehicle occupant just prior to contact with the large vehicle occupant;

[0020] Figure 5 is a front view of the airbag of Figure 4 after contact with the large vehicle occupant;

[0021] Figure 6 is a front view of the airbag of Figure 1 inflating beside a small vehicle occupant just prior to contact with the small vehicle occupant;

[0022] Figure 7 is a front view of the airbag of Figure 6 after contact with the small vehicle occupant;

[0023] Figure 8 is a side view of a second embodiment of the airbag according to the principles of the present invention;

[0024] Figure 9 is a section view along line B-B of the airbag of Figure 8;

[0025] Figure 10 is an outer unstitched fabric for the two outer fabric layers of an airbag according to a third embodiment of the present invention;

[0026] Figure 11 is an inner unstitched fabric for the two inner fabric layers of the airbag of Figure 10; and

[0027] Figure 12 is a section view of the airbag of Figure 10. .

DETAILED DESCRIPTION

[0028] Referring now to the drawings, an airbag embodying the principles of the present invention is illustrated in Figure 1. The structure of the airbag according to a first embodiment in the form of a side airbag is now described with reference to Figures 1 to 3. As its primary components, the airbag includes three chambers, namely the main chamber 10, the pelvic chamber 20 and the auxiliary chamber 30 (see Figure 1). The main chamber 10 and the pelvic chamber 20 serve to restrain a vehicle occupant, while the auxiliary chamber 30 primarily serves to regulate pressure within the main chamber 10. The main chamber 10 is generally arranged, upon inflation, adjacent to an upper body (i.e. thorax) area of a vehicle occupant (see Figures 4-7). Likewise, the pelvic chamber 20 is arranged adjacent to a pelvic area of a vehicle occupant.

[0029] As can best be seen from Figures 2 and 3, the auxiliary chamber 30 is sewn onto the main chamber 10 by means of seam areas 42. Furthermore,

the main chamber 10 and the auxiliary chamber 30 are connected with each other by means of a connecting opening 14, so that exchange of gas can take place between the main chamber 10 and the auxiliary chamber 30.

[0030] Auxiliary chamber 30 is again itself formed in two pieces, of an inner chamber 32 with an inner fabric layer 32a and an outer chamber 36 with an outer fabric layer 36a (see Figure 3). The aforementioned connecting opening 14 is a common opening between a fabric layer 10a of the main chamber 10 and the outer fabric layer 36a of the auxiliary chamber 30.

[0031] The inner chamber 32 and the outer chamber 36 are each basically tubular in form as can best be seen in Figure 1. In this view, the outer fabric layer 36a is shown broken open in a certain area, so that the inner chamber 32 is visible. Inner chamber 32 and outer chamber 36 include a common front side 40 in which an outflow opening 35 is located, which connects the interior of the inner chamber 32 with the environment outside of the airbag.

[0032] A valve opening 34 is located in the inner fabric layer 32a, which connects the inner chamber 32 with the outer chamber 36 (see Figures 1 to 3). If the airbag can expand unhindered (this corresponds to the situation shown in Figures 1 to 3), the main chamber 10 is connected with the outside environment (i.e. gas can flow out of the main chamber into the environment). In this situation, a gas path is as follows: gas first flows from main chamber 10 through connecting opening 14 into outer chamber 36, from there through valve opening 34 into inner chamber 32 and from there through outflow opening 35 to the outside. Depending on the configuration of a gas generator (not shown) and the

geometry of the airbag, a certain internal pressure is created in the main chamber 10.

[0033] The valve opening 34 and the connecting opening 14 can be in the form of holes in the respective fabric layers or gas-permeable fabric areas.

[0034] If a part of the outer fabric layer 36a is pressed against the valve opening 34, the valve opening 34 is completely or partly closed and the flow of gas from the main chamber 10 to the outside is throttled or completely blocked, and a higher internal pressure is created in the main chamber 10 with a given gas generator. Therefore a section of the outer fabric layer 36a serves in this embodiment as a closing element, to block or throttle the gas flow.

[0035] The mode of functioning of an airbag according to the present invention, when installed in a motor vehicle, is described with reference to Figures 4 to 7, whereby the inside of the vehicle is designated with reference letter F.

[0036] Figure 4 shows the airbag inflating next to a large vehicle occupant G during a side-on collision. If relative movement occurs between the large occupant G and the airbag, the shoulder area of the large occupant G comes into contact with the auxiliary chamber 30 (see Figure 5). This results in the outer fabric layer 36a (see Figure 4) covering the valve opening 34, which stems the gas flow from the main chamber 10. This leads to a large internal pressure and therefore to a greater firmness of the main chamber 10, which is sufficient to protect an upper body or thorax area of the large, and generally heavy, occupant G.

[0037] Figures 6 and 7 show a situation similar to that described above except with a small occupant K. Here too, in the case of a side-on collision a relative movement occurs between the small occupant K and the airbag. However, the shoulder area is located under the auxiliary chamber 30, so that the outer fabric layer 36a is not pressed against the valve opening 34. This results in the gas path from the main chamber 10 to the outflow opening 35 remaining free, resulting in a lower pressure in the main chamber 10.

[0038] Figure 8 shows a second embodiment in a side view. This embodiment includes a main chamber 10 and an auxiliary chamber 30, but no pelvic chamber 20; such a chamber can, however, be present as an option in an airbag implemented in this way. The main chamber 10 and auxiliary chamber 30 are formed by the outer fabric layers 51 and 52 being sewn together around their perimeter and in the transitional area between the main chamber 10 and the auxiliary chamber 30 at a connecting area 57 (see Figure 9). This results in two connecting openings 14 being formed, respectively located on the left and right of the connecting area 57.

[0039] The outflow opening 35 which is located in the first outer fabric layer 51 is covered by a covering fabric 64 whose first and second sides 64a and 64b are not fastened to the first outer fabric layer 51, so that gas coming from the outflow opening 35 can enter the interior of the vehicle. If the auxiliary chamber 30 is pressed onto the inner structure of the motor vehicle, for example by the shoulder of the occupant, the outflow opening 35 is closed by the covering fabric

64 contacting the inner structure, stopping the gas flow. The covering fabric therefore forms the closing element. The basic functional principle is therefore identical with that of the first embodiment.

[0040] Figures 10 to 12 show a variant of the second embodiment described above. The difference is that two auxiliary chambers 30a and 30b are provided (see Figure 12). Because of the special arrangement of the two auxiliary chambers 30a and 30b, desirable outflow behaviour can be achieved resulting in an improved means for closing the outflow openings is also implemented.

[0041] The cover of the airbag is manufactured of only two fabric sections. Figure 10 shows a first fabric section 54, from which a first outer fabric layer 51 and a second outer fabric layer 52 are created. Between these layers, the main chamber 10 is created beneath a broken line L, while the auxiliary chambers 30a and 30b are created above the broken line L (see Figure 12). This variant also includes a connecting area 57. A gas generator opening 59 is provided in the first fabric section 54 in the transitional area between the first outer fabric layer 51 and the second outer fabric layer 52.

[0042] Figure 11 shows a second fabric section 50, from which a first inner fabric layer 55 and a second inner fabric layer 56 are formed. In addition, an outer capture tether 60 is located on the second fabric section 50. The two outflow openings 35 are located in the second fabric section 50 as well as four

inner capture tethers 58, which are connected to the first outer fabric layer 51 or the second outer fabric layer 52 during the manufacturing process.

[0043] The two fabric sections 50 and 54 are sewn together as described in the following text. The second fabric section 50 is folded over along a mid line M and then the first inner fabric layer 55 is sewn together with the first outer fabric layer 51 along the first seam 53a and the second inner fabric layer 56 is sewn together with the second outer fabric layer 52 along the second seam 53b. Furthermore, the inner capture tethers 58 are joined with the second fabric section 50 and sewn together to respective opposite areas of the outer fabric layers 51 and 52. Finally, all four fabric layers are joined together in connecting area 57 by means of sewing. As a last step, the top edges of the auxiliary chambers 30a and 30b are joined together by means of outer capture tether 60. This results in the configuration shown in Figure 12, which is a section of the present embodiment similar to the representation of Figure 9 and which shows the situation when the airbag is fully expanded.

[0044] All four fabric layers are sewn together in the connecting area 57. Below this connecting area 57 is the main chamber 10, above the connecting area 57 are the two auxiliary chambers 30a and 30b. The thickness of the two auxiliary chambers is limited by the two capture tethers 58 respectively. The gas flow from the main chamber 10 into the auxiliary chambers 30a and 30b occurs to the left and right of the connecting area 57 (this cannot be seen from the representation in Figure 12). The two auxiliary chambers 30a and 30b are connected with each other at their upper ends by means of the outer capture

tether 60, so that an intermediate area 62, which is basically open to the top and sides, is created between the two auxiliary chambers 30a and 30b. The two outflow openings 35 end in this intermediate area 62, so that direct gas flow onto the vehicle occupant or the side structure of the vehicle is avoided. Outflow openings 35 are closed if the two auxiliary chambers 30a and 30b are pressed onto one another by an external obstacle, for example the shoulder of the occupant. This means the one auxiliary chamber 30a and 30b forms the closing element of the other auxiliary chambers 30a or 30b.

[0045] As a person skilled in the art will readily appreciate, the above description is meant as an illustration of implementation of the principles of this invention. This description is not intended to limit the scope or application of this invention in that the invention is susceptible to modification, variation and change, without departing from the spirit of this invention, as defined in the following claims.